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Evaluation Report

RELIABILITY DEPARTMENT

TEST REPORT NO. TR 7-0075

J.P.L. Task No. 53

TEST PERFORMED BY

LIBRASCOPE RELIABILITY DEPARTMENT

ON

RADIO FREQUENCY CONNECTORS

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ABSTRACT

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This report presents the results of a test program comparing the mechanical and electrical characteristics of Radio Frequency Connectors when subjected to a sequence of environments. Samples from eleven different manufacturers were subjected to thermal shock, altitude, humidity, and salt spray. Federated Radio, Amphenol, Micon, Sealectro and Microdot submitted subminiature connector types. Bendix, General RF, Cannon, and Gremar submitted miniature connector types. Aviel and Automatic Metals submitted regular connector types.

The test results clearly demonstrated similar characteristics between the subminiature, miniature and regular RF connector types.

The miniature and subminiature connectors submitted by Amphenol, Federated Radio, Cannon, General RF and Gremar failed the requirements of the contact resistance, cable retention and cable twist tests.

All connector types, with the exception of Amphenol and Cannon, exhibited a steady electrical degradation of the insulation resistance parameter during exposure to humidity, and especially, salt spray environments.

Connectors from all eleven manufacturers met the center conductor push-out parameter requirements.

Amphenol and Cannon connectors were superior electrically. The poorest electrically were the Micon, Federated Radio and Microdot connector types.

Author

ABSTRACT (Continued)

The regular connector types manufactured by Aviel Electronics and Automatic Metal Products, due to their physical size, excelled over the subminiature and miniature connector types in the cable retention and cable twist parameters.

1.0 INTRODUCTION-

1.1 Objectives:

Four hundred RF Connectors from eleven manufacturers, which comprised of miniature, subminiature and regular connector types were submitted by Jet Propulsion Laboratory for test. The test objectives were 1) to evaluate the connectors for use in the Ranger and/or Mariner programs and 2) to up-date Jet Propulsion Laboratory's Preferred Parts List.

1.2 Sample Identification and Description:

TABLE I

MANUFACTURER	CONFIGURATION			
	Straight Angle	Right Angle	Bulkhead	Panel
Amphenol	27-7	27-26	27-9 27-10	
Automatic Metals	300-T1010A 300-T1000A		75-T3501	
Aviel Electronics		945-011		900-581
Bendix	21-31011-7		21-31022-5	
Cannon	CX-PL-F-37 CX-JC-M-37			CX-RB1-M-O
Federated Radio	037575 037775	037675	037875 058350	
General RF Fittings	166B 2200	2220A	2265 2016B	
Gremar	6636R	6613R	6643R	
Micon	1001 1002 1101 1102 1201 1202	1110 1109 1019		

1.0 INTRODUCTION (Cont.) -

1.2 Sample Identification and Description (Cont.):

TABLE I (Cont.)

MANUFACTURER	CONFIGURATION			
	Straight Angle	Right Angle	Bulkhead	Panel
Micon	1301 1302			
Microdot	32-23 31-34 52-463	32-15 52-371 53-570	31-02 31-50 51-509	
Sealectro	3100	3105	3102	

1.3 Test Plan:

Four hundred connectors were received from Jet Propulsion Laboratory for testing purposes. Each connector type was identified by manufacturer and serial number prior to testing.

All measurements were performed at room ambient temperature (25° C) unless otherwise specified.

Prior to the assembly of the RF connectors, the following measurements were performed: male pin diameters, mounting hole clearance, contact gage and female-pin-well depth.

After each connector type was assembled to its specified coax cable, notations were made describing the assembly techniques, center conductor pin alignment and overall soundness of construction.

1.0 INTRODUCTION (Cont.)-

1.3 Test Plan (Cont.):

The RF connectors were mated to their respective mating connectors and divided into six groups. Table II identifies each mated connector test sample and its manufacturer by group. An "X" denotes one mated connector test sample and a blank space indicates no test sample.

TABLE II
Mated Connectors by Manufacturer and Group

MANUFACTURER	MATED CONNECTOR No.	:	Mated to No.	GROUP 1	2	3	4	5	6
Amphenol Corp. (AMP)	27-7	:	27-9	X	X		X	X	X
	27-26	:	27-9	X	X		X	X	X
	27-7	:	27-10	X	X		X	X	X
	27-26	:	27-10	X	X		X	X	X
Aviel Electronic Inc. (AVL)	945-011	:	900-581	X	X	X	X	X	X
Automatic Metal Products (AM)	300-T1000A	:	75-T3501	X	X	X	X	X	X
	300-T1010A	:	75-T3501	X	X	X	X	X	X
Bendix (BX)	21-31011-7	:	21-310225	X	X	X	X	X	X
Cannon Electric Company (CP)	CX-PL-F-37	:	CX-JC-M-37	X	X	X	X	X	X
	CX-PL-F-37	:	CX-RB1-M-0	X	X	X	X	X	X
Federated Radio Corp. (FXR)	037675	:	037875	X	X		X	X	X
	037675	:	037775	X	X		X	X	X
	037675	:	058350	X	X		X	X	X
	037575	:	058350	X	X		X	X	X
	037575	:	037875	X	X		X	X	X
General Radio Frequency Fittings Inc. (GRFF)	2200	:	2265	X	X		X	X	X
	2221A	:	2265	X	X	X	X	X	X
	166B	:	2016B	X	X	X	X	X	X
Gremar Manufacturing Co. (GRM)	M6636R	:	M6643R	X	X	X	X	X	X
	M6613R	:	M6643R	X	X	X	X	X	X

1.0 INTRODUCTION (Cont.)-

1.3 Test Plan (Cont.):

TABLE II (Cont.)

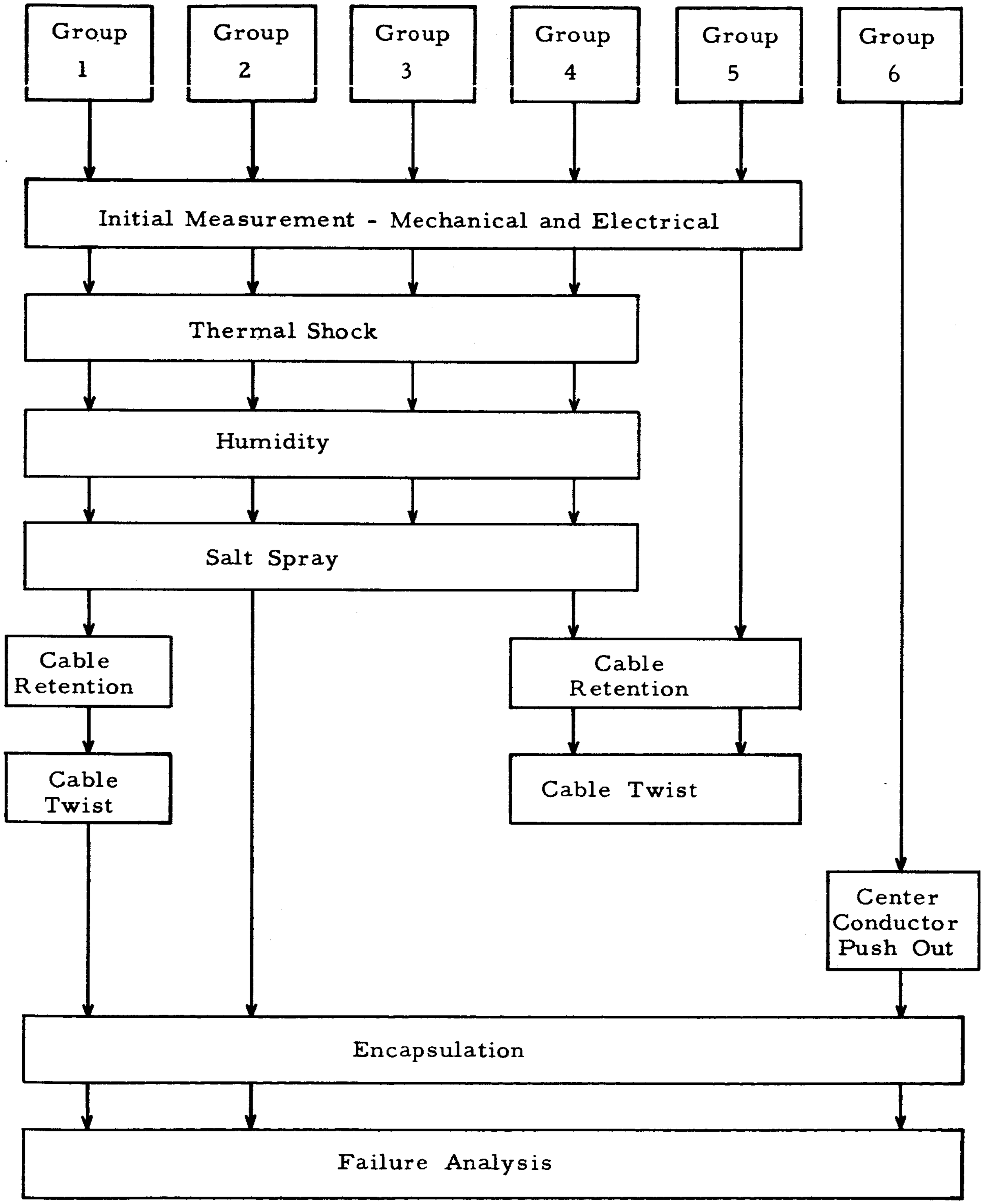
MANUFACTURER	MATED CONNECTOR No.	Mated to No.	GROUP 1	2	3	4	5	6
Micon Electronics Inc. (MN)	1001	1002	X	X	X	X	X	X
	1001	1019	X	X	X	X	X	X
	1101	1102	X	X	X	X	X	X
	1101	1109	X	X	X	X	X	X
	1201	1202	X	X	X	X	X	X
	1301	1302	X	X	X	X	X	X
	1110	1102	X	X	X	X	X	X
Microdot, Inc. (MDOT)	32-23	31-02	X	X	X	X	X	X
	32-23	33-53	X	X				
	32-15	31-50	X	X	X	X	X	X
	32-15	31-34	X	X			X	X
	52-371	31-50	X	X	X	X	X	X
	52-371	31-34	X			X		
	52-463	51-509	X	X		X	X	X
	52-463	53-570	X	X		X	X	X
Sealecto Corp. (SLO)	3100	3102	X	X	X	X	X	X
	3105	3102	X	X	X	X	X	X

At the conclusion of grouping the test samples, the initial electrical tests were performed: dielectric strength (local atmospheric pressure), dielectric strength (high vacuum pressure), insulation resistance and contact resistance (direct and indirect methods).

The post environmental measurements consisted of dielectric strength (local atmospheric pressure), insulation resistance and contact resistance (indirect method).

2.0 TEST PROCEDURES-

2.1 Test Sequence Flow Chart:



2.0 TEST PROCEDURES (Cont.)-

2.2 Mechanical Tests:

All parts were inspected for type and damage.

2.2.1 Male Pin Diameter:

All male pins were measured for length and for diameter. The diameter of each pin was measured at three locations along the length of the pin.

The male pins of the factory assembled connectors were measured with an American Optical 15X Microscope having an eyepiece graduated in 0.001 inches.

2.2.2 Mounting Hole Clearance:

The major thread diameter measurements for all panel and bulkhead type connectors were made with an L. S. Starrett Micrometer.

2.2.3 Contact Gage Test:

The contact gage test was made by measuring the force required to insert the male pin of each connector type into its respective female pin. A representative steel male pin, of correct diameter, was used in lieu of the actual male pins for each connector type. All steel male pins used in this test were furnished by Jet Propulsion Laboratory. The test was performed by Librascope personnel at Jet Propulsion Laboratory on the Instron Force Gage Tester and Recorder. Data sheets were prepared from the graphic recording of the force required to mate the male and female pins under test.

2.0 TEST PROCEDURES (Cont.)-

2.2 Mechanical Tests (Cont.):

2.2.4 Female Well Depth:

The male pin of each connector was inserted into its respective female mating pin to verify that the shoulder of the male pin met the entrance of the female pin.

2.2.5 Assembly Evaluation Test:

As each individual connector type was being assembled, notations were made describing the clarity of the written instructions and their diagrams, assembly difficulties as a result of the connector design, center conductor pin misalignments and their causes and overall mechanical soundness based upon the above observations.

2.3 Electrical Tests:

2.3.1 Dielectric Strength Test:

2.3.1.1 Associated Research Hypot, Model 4222, was used as the test instrument. A test potential of 1500V RMS, 60 cps was applied, under ambient conditions, between the coax center conductor and the mated connector shell for a duration of one minute. Readings less than 1500V RMS were considered failures.

2.3.1.2 A second dielectric strength test potential of 100V RMS, 60 cps was applied with the same instrument to the coax center conductor and the mated connector shell for one minute at a pressure of 1×10^{-7} mm Hg. Readings less than 100V RMS were considered failures.

2.0 TEST PROCEDURES (Cont.) -

2.3 Electrical Tests (Cont.):

2.3.1.2 (Continued):

The vacuum system used was a NRC 6" diffusion pump system with a Cook hot cathode metering system.

2.3.2 Insulation Resistance:

Sticht Megohmeter, Model 29A was used as the test instrument. A test potential of 500V DC was applied to the coax center conductor and the mated connector shell for a duration of one minute under ambient conditions. Readings less than 1K megohms were considered failures.

2.3.3 Contact Resistance:

All mated connectors were engaged and disengaged a minimum of three times prior to performing the contact resistance measurements.

Four inches of cable length was used on the connectors to minimize cable resistance. The cable resistances were measured prior to assembly of the connectors.

2.3.3.1 The indirect method was performed by driving one ampere of current through the mated connector contacts and measuring the resulting voltage drop with a digital voltmeter and subtracting the measured value of the coax cable resistance.

2.3.3.2 The direct method was performed by measuring the mated connector directly on a Wheatstone resistance bridge and substracting the measured coax cable resistance.

2.0 TEST PROCEDURES (Cont.)-

2.4 Environmental Tests:

2.4.1 Thermal Shock:

The mated connector samples were subjected to five cycles of thermal shock. One cycle consisted of 20 minutes exposure at each temperature extreme of +175° C and -65° C with a maximum transistion time of two minutes.

At the conclusion of the thermal shock test, the samples were examined for physical damage. Then the dielectric strength test (Paragraph 2.3.1.1) and contact resistance test (Paragraph 2.3.1.2) were performed.

2.4.2 Humidity:

The mated connector samples were subjected to steady state humidity for 144 hours at 95 per cent relative humidity and a temperature of 40° C.

The open ends of the coax cables were wrapped with tape to prevent any moisture from collecting along the center conductor wire and the dielectric material.

At the end of 144 hours of humidity exposure, the mated test samples were removed from the chamber one at a time, inspected for physical damage and then tested for insulation resistance (Paragraph 2.3.2).

2.0 TEST PROCEDURES (Cont.)-

2.4 Environmental Tests (Cont.):

2.4.2 Humidity (Cont.):

After the conclusion of the insulation resistance test, the mated connector samples were allowed to dry at room ambient conditions for a minimum period of 4 hours. At the end of the drying period, the test samples were tested for dielectric strength (Paragraph 2.3.1.1) and contact resistance (Paragraph 2.3.3.1).

2.4.3 Salt Spray:

The mated connector samples were subjected to 48 hours of salt spray at 40° C. The salt solution concentration was 5% by weight with a pH of 7.2 - 7.6 as specified by Jet Propulsion Laboratory.

At the conclusion of the salt spray test, the test samples were washed in luke warm tap water, then dried in a chamber at 40° C for 8 hours.

The test samples were removed from the drying chamber and inspected for pitting, corrosion, and other possible damage after which the insulation test (Paragraph 2.3.2) and the contact resistance test (Paragraph 2.3.3.1) were performed.

2.0 TEST PROCEDURES (Cont.)-

2.4 Environmental Tests (Cont.):

2.4.4 Cable Retention:

The mated connector samples were rigidly secured with the coax cable ends free from the securing device. Each coax cable was pulled with a force of 17 pounds in a direction in line with the coax cable center conductor. No bending or twisting of the coax cable was permitted during this test.

An ohmmeter was inserted between the free coax cable ends to monitor possible opens between the mated connectors under test.

Any opens or damage occurring at less than 17 pounds of pull was considered a failure.

2.4.5 Cable Twist:

A torque test of 5 lb-in. was applied to the mated connector samples at the connector-to-coax junction via the coax cables. Only those samples that did not fail the cable retention test (Paragraph 2.5.1) were tested, first in the CW direction and then in the CCW direction (Providing no failure occurred in the CW direction).

Any separation or damage occurring at less than 5 lb-in. was considered a failure.

2.0 TEST PROCEDURES (Cont.) -

2.4 Environmental Tests (Cont.):

2.4.6 Center Conductor Push Out:

The mated connector samples were each assembled on a 12 foot length of coax cable, the male on one end of the coax and the female on the other end. The coax cable was wound on a wooden mandrel with a diameter 10 times greater than that of coax cable diameter. The male and the female connectors were then joined together.

Mounted in this manner, the test samples were subjected to 3 cycles of temperature cycling. One cycle consists of 3 hours at 140° F, 1/2 hour at room ambient and 3 hours at 40° F.

At the conclusion of the temperature cycling, each test sample was taken off the mandrel and stretched out straight with a pull not exceeding 5 pounds. The mated connectors were disconnected and the center conductor pins and coax cable-to-connector junctions excamined for damage and displacement.

2.5 Encapsulation:

At the conclusion of the testing sequence mated connector test samples were encapsulated in clear epoxy. The encapsulated samples were submitted to Jet Propulsion Laboratory where they were machined down to a 50% cut-away view.

2.0 TEST PROCEDURES (Cont.)-

2.5 Encapsulation (Cont.):

The machined encapsulated connectors were then returned to the testing facility and used in the failure analysis.

2.6 Failure Analysis:

The cut-away encapsulated mated connectors were visually inspected under an American Microscope (15 power).

3.0 TEST RESULTS-

3.1 Amphenol Corporation:

3.1.1 Inspection: (See Para. 2.2)

Ten straight-angle connectors (27-7), ten right-angle connectors (27-26), 20 bulkhead connectors (ten 27-9 and ten 27-10) were inspected upon receipt and were found to be correct in quantity and type, and exhibited no apparent physical damage.

3.1.2 Male Pin Diameter: (See Para. 2.2.1)

Ten male pins of connector 27-9 were approximately 0.021 inches in diameter. Manufacturer's specifications of male pin diameters were not available for comparison.

The male pins of connector 27-10 varied from 0.0202 to 0.0211 inches in diameter. The length of these male pins varied from 0.3091 to 0.3102 inches. Manufacturer's specifications were not available for comparison.

3.1.3 Mounting - Hole Clearance: (See Para. 2.2.2)

The major thread diameter of ten 27-9 connectors ranged from 0.190 to 0.192 inches. Ten 27-10 connectors ranged

3.0 TEST RESULTS (Cont.) -

3.1 Amphenol Corporation (Cont.):

3.1.3 Mounting - Hole Clearange (Cont.):

from 0.189 to 0.191 inches. Both connector types met the tolerances for a NF10-32 thread specified by the manufacturer.

3.1.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on the 27-7 female connectors ranged from 1.0 ounce to 4.2 ounces. The force measured on the 27-26 female connectors ranged from 1.9 ounces to 2.3 ounces.

3.1.5 Female-Well Depth: (See Para. 2.2.4)

All 10 male pins tested of type 27-9 were longer than the depth of the female well on types 27-7 and 27-26 connectors but appear to be designed in this manner. The actual seating depth intended for the 27-9 male pin cannot be determined from the manufacturer's drawing.

3.1.6 Assembly Evaluations: (See Para. 2.2.5)

The assembly of the 27-7, 27-10 and 27-26 connectors was accomplished with little difficulty. No misalignment of the center conductor pins was noted on any of the assembled conductors. The center conductor pins on all connector types above were captivated by the connector shell.

3.1.7 Dielectric Strength: (See Para. 2.3.1)

Two of the 22 samples tested failed to meet the 1500V RMS requirement under standard laboratory conditions and

3.0 TEST RESULTS (Cont.) -

3.1 Amphenol Corporation (Cont.):

3.1.7 Dielectric Strength (Cont.):

exhibited breakdown from 40 to 600 V RMS. All of the 22 samples tested met the test requirement of 100V RMS under high vacuum conditions.

3.1.8 Insulation Resistance: (See Para. 2.3.2)

All of the 22 samples tested met the test requirements of 1000 megohms under standard laboratory conditions.

3.1.9 Contact Resistance: (See Para. 2.3.3)

Fifteen of 22 samples failed to meet the 5 milliohm requirement of this test under standard laboratory conditions and exhibited contact resistances of 13 to 101 milliohms at a level of 1 ampere. Groups 1 and 2 of samples 27-7:27-10 were open-circuited and were catastrophic failures. Group 1 of sample 27-26:27-10 were open circuited and was a catastrophic failure.

Twelve of 16 samples failed to meet the 5 milliohm requirement of this test under standard laboratory conditions and exhibited contact resistances of 5 to 11 milliohms when measured directly on a Wheatstone Bridge.

3.1.10 Thermal Shock: (See Para. 2.4.1)

Eight samples were tested and met the requirements of this test. There was no evidence of physical damage to the connectors. The RG174/U coaxial cable used on the connectors did not withstand the high test temperature of

3.0 TEST RESULTS (Cont.) -

3.1 Amphenol Corporation (Cont.):

3.1.10 Thermal Shock (Cont.):

175° C and deteriorated completely beyond usage. Therefore, no valid post electrical measurements could be made on the entire set of test samples. At this point, Mr. Protich of Jet Propulsion Laboratory authorized a new set of connector samples to be mounted on new RG188/U cables and a rerun of the thermal shock test at the same maximum temperature of 175° C. Groups 1, 2 and 4 of samples 27-7:27-9 and 27-7:27-10 were replaced by Jet Propulsion Laboratory.

Initial measurements were made on the sample replacement which included dielectric strength, insulation resistance and contact resistance. All samples passed dielectric strength and insulation resistance. All samples exceeded the maximum limit of 5 milliohms contact resistance and ranged from 21 to 44 milliohms when measured indirectly with the 1 ampere of current method.

All further tests and test results are for the new test sample replacement. All 6 samples met the thermal shock requirements. All 6 samples met the 1500V RMS post thermal shock dielectric strength test.

3.0 TEST RESULTS (Cont.) -

3.1 Amphenol Corporation (Cont.):

3.1.10 Thermal Shock (Cont.):

All 6 samples exhibited a decrease in contact resistances from the initial values. The range was 18 to 36 milliohms and exceeds the 5 milliohm limit requirement.

3.1.11 Humidity: (See Para. 2.4.2)

Six samples were tested and met the requirements of this test with no evidence of rust or corrosion, or physical damage to the test samples.

Six samples were tested and met the requirements of the 1000 megohms insulation resistance test performed at the end of the humidity cycle while still under humidity conditions.

All 6 samples met the requirements of the post humidity dielectric strength test performed 4 hours after drying at room temperature.

All 6 samples exhibited an increase in contact resistance at the post humidity measurement point. The range of contact resistances was 22 to 40 milliohms and exceeds the 5 milliohm limit.

3.1.12 Salt Spray: (See Para. 2.4.3)

Eight samples were tested and met the requirements of this test. No evidence of physical damage was observed.

3.0 TEST RESULTS (Cont.)-

3.1 Amphenol Corporation (Cont.):

3.1.12 Salt Spray (Cont.):

One of the 6 samples tested failed to meet the 1000 megohm insulation resistance requirement and exhibited a break-down at 300 megohms.

All six samples failed to meet the 5 milliohm contact resistance requirement and exhibited resistances of 25 to 42 milliohms and showed an increase over the previous readings.

3.1.13 Cable Retention: (See Para. 2.5.1)

Six of the eight samples tested failed to meet the 17-pound pull requirement. In all instances, the entire cable separated from the connector assembly. The failures occurred from 5 to 16 pounds.

3.1.14 Cable Twist: (See Para. 2.5.2)

Six samples were tested and did not meet the 5 pound-inches requirement. Failures occurred from 4.5 to 16.5 ounce-inches.

3.1.15 Center Conductor Push Out: (See Para. 2.5.3)

Four samples were tested and met the requirements of this test. No evidence of physical damage was observed.

3.0 TEST RESULTS (Cont.) -

3.1 Amphenol Corporation (Cont.):

3.1.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test sample had destroyed the evidence of failures, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.1.17 Conclusions:

Study of the cable retention and cable twist failures has shown the failures to be directly related to insufficient mechanical strength on the part of the shielding of the coax cable used for the test.

Contact resistances much greater than five milliohms is apparently due to insufficient size of the center conductor or insufficient contact area between male and female center conductor pins or both.

Causes for dielectric strength and insulation resistance failures could not be determined positively. Probable causes would be poor assembly, such as inadequate trimming of the braided shield thereby permitting shield pigtails to come near or in contact with the center conductor pin, insufficient spacing of the center conductor pin from the point of termination of the coax cable shield, or the infiltration of moisture into the connector and cable assembly during humidity and salt spray tests.

3.0 TEST RESULTS (Cont.)-

3.2 Aviel Electronics:

3.2.1 Inspection: (See Para. 2.2)

Six right angle connectors (945-011) and six bulkhead type connectors (900-581) were inspected upon receipt from Jet Propulsion Laboratory and were found to be correct in quantity and type and exhibited no apparent physical damage.

3.2.2 Male Pin Diameter: (See Para. 2.2.1)

Six male pins of connector 945-011 vaired from approximately 0.060 inches to approximately 0.063 inches in diameter. Male pin diameters were not specified on the manufacturer's drawings.

3.2.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameter of six 900-501 connectors ranged from 0.576 to 0.583 inches. The clearance requirement for the mounting was 0.578 inches per the manufacturer's drawing.

3.2.4 Contact Gage: (See Para. 2.2.3)

The force measured for inserting a female pin on the the male pin assembly at the coax cable end of type 945-011 varied from 6.0 to 10.4 ounce-inches. The insertion force measured on the 900-581 female connectors varied from 4.3 to 4.9 ounce-inches.

3.0 TEST RESULTS (Cont.)-

3.2 Aviel Electronics (Cont.):

3.2.5 Female-Well Depth:

All six female pins of connector 900-581 had well-depths greater than the length of the mating male pin.

3.2.6 Assembly Evaluations: (See Para. 2.2.5)

No cable assembly instructions were available for connector type 945-011, therefore the manufacturer's drawings were used as a guide. No assembly difficulties were encountered on the 945-011 connector since it is quite basic in design.

The 900-581 connector is factory assembled. No center conductor pin misalignment was noted on any of the connectors. The center conductor pins are well captivated by the connector shells.

The threads on one of the 6 samples stripped during assembly. Since the connector shell is made of gold iridited aluminum, the threads that accepts the cable-retaining nut can easily be stripped when tightning it down.

3.2.7 Dielectric Strength: (See Para. 2.3.1)

Five samples were tested and met the requirements of this test under standard laboratory atmospheric pressure and 100V RMS under high vacuum conditions.

3.2.8 Insulation Resistance: (See Para. 2.3.2)

Five samples were tested and met the requirements of this test under standard laboratory conditions.

3.0 TEST RESULTS (Cont.) -

3.2 Aviel Electronics (Cont.):

3.2.9 Contact Resistance: (See Para. 2.3.3)

Five samples were tested and failed to meet the 5 milliohm requirement of this test. The samples exhibited contact resistance from 19 to 20 milliohms at a current level of one ampere under standard laboratory conditions.

The five mated samples met the 5 milliohm maximum requirement of this test when measured on a Wheatstone Bridge under standard laboratory conditions.

3.2.10 Thermal Shock: (See Para. 2.4.1)

Four samples were tested and met the requirements of this test. There was no evidence of physical damage to the connectors. However, the coaxial cables (RG9A/U) assembled to the test samples did not withstand the high temperature exposure and deteriorated beyond use. Therefore, no valid post electrical measurements could be made on any of these test samples.

As authorized by Mr. Protich at Jet Propulsion Laboratory, the four test samples were reassembled to new pieces of RG9A/U cable and the dielectric strength, insulation resistance and contact resistance (indirect method only) tests were retaken as reference data prior to the thermal shock retest. The four new samples met the requirements of the thermal shock retest at a reduced temperature of 75° C with no

3.2.10 Thermal Shock (Cont.):

physical damage to the connector samples.

All four test samples met the requirements of the post thermal shock insulation resistance test of 1000 megohms minimum.

All four test samples exceeded the maximum requirements of the post thermal shock contact resistance test of 5 milliohms at a current level of one ampere. Test values were 5 to 10 milliohms resistance.

3.2.11 Humidity: (See Para. 2.4.2)

All four test samples met the requirements of this test with no evidence of rust or corrosion or physical damage to the test samples.

All four test samples met the requirements of the post humidity insulation resistance and dielectric strength tests.

All four test samples failed to meet the post humidity contact resistance requirement of 5 milliohms. The measured values ranged from 6 to 7 milliohms.

3.2.12 Salt Spray: (See Para. 2.4.3)

The four samples tested were badly corroded on the plating, with some corrosion appearing on the base metal where the plating had lifted.

3.0 TEST RESULTS (Cont.) -

3.2 Aviel Electronics (Cont.):

3.2.12 Salt Spray (Cont.):

Three of four samples met the requirements of the post salt spray insulation resistance test of 1000 megohms. Group 2 exhibited a short circuit and was a catastrophic failure.

All four test samples failed to meet the post salt spray contact resistance requirement of 5 milliohms at a current level of one ampere and showed an increase over the previous readings.

3.2.13 Cable Retention: (See Para. 2.5.1)

Three test samples were tested and met the 17-pound retention requirement of this test and exhibited no damage.

3.2.14 Cable Twist: (See Para. 2.5.2)

One of the three mated samples tested failed to meet the 5 pound-inches requirement of this test. Group 5 (connector 945-011) failed at 38 ounce-inches in the CW direction. The CCW direction was not performed. (See Para. 3.2.17).

3.2.15 Center Conductor Push Out: (See Para. 2.5.3)

One sample was tested and met the requirements of this test and exhibited no physical damage.

3.2.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the

3.0 TEST RESULTS (Cont.) -

3.2 Aviel Electronics (Cont.):

3.2.16 Failure Analysis (Cont.):

encapsulated test samples had destroyed the evidence of failures, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.2.17 Conclusions:

The one sample that failed the cable twist test failed because this particular sample had the cable retaining nut stripped during assembly. (See Para. 3.2.6).

Contact resistance requirements were not met for the one ampere indirect method because of insufficient contact area. The center conductor pins are of sufficient diameter for carrying 1 ampere of current.

3.3 Automatic Metals Products Corporation:

3.3.1 Inspection: (See Para. 2.2)

Twelve straight-angle connectors (six 300-T1000A and six 300-T1010A) and 12 bulkhead connectors (75-T3501) were inspected upon receipt from Jet Propulsion Laboratory and were found to be correct in quantity and type. The six 300-T1010A connectors were cadmium plated and exhibited more than a moderate amount of tarnishing. The remaining connector types were silver plated and showed no tarnishing.

3.3.2 Male Pin Diameter: (See Para. 2.2.1)

The six male pins of connectors 300-T1010A exhibited diameters of 0.0480 to 0.0491 inches. The six male pins of

3.0 TEST RESULTS (Cont.) -

3.3 Automatic Metals Products Corporation(Cont.):

3.3.2 Male Pin Diameters (Cont.):

connectors 300-T1000A exhibited diameters of 0.0490 to 0.0500 inches. Male pin diameters were not specified on the manufacturer's drawings.

3.3.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameter of 12 type 75-T3501 connectors ranged from 0.499 to 0.500 inches and met the clearance requirements for a 1/2 inch diameter mounting hole as specified by the manufacturer.

3.3.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on the 75-T3501 female connector ranged from 2.0 to 18.0 ounces.

3.3.5 Female-Well Depth: (See Para. 2.2.4)

All 12 female connectors had well depths greater than the length of the mating male pins.

3.3.6 Assembly Evaluations: (See Para. 2.2.5)

The 75-T3501 connectors are factory assembled units. No assembly instructions were available for the 300-T1000A, and 300-T1010A connectors. The manufacturer's drawings were used as a guide. No assembly difficulties were encountered since the above mentioned connectors are large in size and quite basic in design. After the assembly of the two types of connectors, no center conductor pin misalignment was noted. The center conductor pins are moderately captivated by the connector shell.

3.0 **TEST RESULTS (Cont.) -**

3.3 **Automatic Metals Products Corporation (Cont.):**

3.3.7 Dielectric Strength: (See Para. 2.3.1)

Ten mated samples were tested and met the test requirements of 1500V RMS under standard laboratory atmospheric pressure and 100V RMS under high vacuum. One sample, 300-T1000A and 75-T3501 in Group 2, broke down at a potential of 1300V RMS at local laboratory pressure of 29.60 inches/Hg.

3.3.8 Insulation Resistance: (See Para. 2.3.2)

Nine mated samples were tested and met the requirement of 1000 megohms or greater. One sample 300-T1000A, Group 2 exhibited a reading of 800 megohms.

3.3.9 Contact Resistance: (See Para. 2.3.3)

Ten mated samples were tested and failed to meet the requirements of 5 milliohms or less and exhibited resistances from 7 to 12 milliohms at a current level of one ampere under standard laboratory conditions.

All 10 samples failed to meet the 5 milliohm requirement when measured directly on a Wheatstone Bridge under standard laboratory conditions and exhibited contact resistances from 23 to 24 milliohms.

3.3.10 Thermal Shock: (See Para. 2.4.1)

Eight mated samples were tested and met the requirements of this test. There was no evidence of physical damage to

3.0 TEST RESULTS (Cont.)-

3.3 Automatic Metals Products Corporation (Cont.):

3.3.10 Thermal Shock (Cont.):

the connectors. However, the coaxial cables (RG9A/U) assembled to the test samples did not withstand the high temperature exposure and deteriorated beyond use. Therefore, no valid post electrical measurements could be made on any of the test samples. The eight test samples were reassembled to new pieces of RG9A/U cable and the dielectric strength, insulation resistance and contact resistance (indirect method only) tests were retaken as reference data prior to the thermal shock retest. The eight samples met the requirements of the thermal shock test at the reduced temperature of 75° C with no physical damage to the connector samples.

One of the eight samples tested failed to meet the post thermal shock dielectric strength test of 1500V RMS and broke down at 300V RMS.

None of the eight samples met the post thermal shock contact resistance requirement of 5 milliohms and exhibited values from 8 to 15 milliohms.

3.3.11 Humidity: (See Para. 2.4.2)

Eight mated samples were tested and met the requirements of this test. No evidence of rust, corrosion or damage was observed. One of the eight mated samples tested failed catastrophically the post humidity insulation resistance test

3.0 **TEST RESULTS (Cont.)-**

3.3 Automatic Metals Products Corporation (Cont.):

3.3.11 Humidity (Cont.):

of 1000 megohms and the dielectric test of 1500V RMS.

All eight samples failed to meet the post humidity contact resistance requirement of 5 milliohms or less. The values ranged from 9 to 10 milliohms.

3.3.12 Salt Spray: (See Para. 2.4.3)

Twelve samples were tested and met the requirements of this test. Four samples exhibited light amounts of corrosion on the silver plating.

Eight of the 12 samples tested failed to meet the post salt spray insulation resistance requirement of 1000 megohms. Two samples exhibited shorts and were catastrophic and two exhibited resistances of 100 to 150 megohms.

None of the eight samples met the post salt spray contact resistance requirement of 5 milliohms. The values ranged from 10 to 15 milliohms.

3.3.13 Cable Retention: (See Para. 2.5.1)

Six samples were tested and met the 17-pound retention requirement of this test and exhibited no damage.

3.3.14 Cable Twist: (See Para. 2.5.2)

Six samples were tested and met the 5 pound-inches twist requirement of this test and exhibited no damage.

3.0 TEST RESULTS (Cont.) -

3.3 Automatic Metals Products Corporation (Cont.):

3.3.15 Center Conductor Push Out: (See Para. 2.5.3)

Two samples were tested and met the requirements of this test and exhibited no physical damage.

3.3.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test sample had destroyed the evidence of failure, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.3.17 Conclusions:

Causes for dielectric strength breakdown and insulation resistance failure were not determinable under the microscope. (See Para. 3.3.16).

The increase in insulation resistance breakdown after the salt spray test was apparently due to infiltration of contaminants and moisture at the connecting ends of the mated connectors.

The causes for failing to meet the contact resistance requirement were apparently due to insufficient contact area between the two mating conductor pins. The center conductor pin diameters are sufficient for carrying one ampere of current.

3.0 TEST RESULTS (Cont.) -

3.4 Bendix Corporation:

3.4.1 Inspection: (See Para. 2.2)

Six straight-angle connectors (21-31011-7) and six bulkhead connectors (21-31022-5) were inspected upon receipt from Jet Propulsion Laboratory and were found to be correct in quantity and type and exhibited no physical damage.

3.4.2 Male Pin Diameter: (See Para. 2.2.1)

The six male pins of connectors 21-31011-7 exhibited diameters of 0.0361 to 0.0372 inches. The manufacturer's drawing specifies they shall be 0.0355 ±0.0010 inches.

3.4.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameters of six 21-31022-5 connectors ranged from 0.246 to 0.247 inches and met the clearance requirements for a 0.250 inch diameter mounting hole specified by the manufacturer.

3.4.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on the female 21-31022-5 connector ranged from 4.5 to 5.0 ounces.

3.4.5 Female-Well Depth: (See Para. 2.2.4)

All six female connectors had well-depths greater than the length of the mating male pins.

3.4.6 Assembly Evaluations: (See Para. 2.2.5)

The assembled connectors exhibited no center conductor pin misalignment, and the conductor pins were either flush or slightly captivated by the connector shell. These two

3.0 TEST RESULTS (Cont.) -

3.4 Bendix Corporation (Cont.):

3.4.6 Assembly Evaluations (Cont.):

connector types are classified as subminiature but are slightly larger than most.

3.4.7 Dielectric Strength: (See Para. 2.3.1)

Eight samples were tested and met the 1500V RMS requirement of this test under standard laboratory atmospheric pressure and 100V RMS under high vacuum.

3.4.8 Insulation Resistance: (See Para. 2.3.2)

Eight samples were tested and met the 100 megohm requirements of this test under standard laboratory conditions.

3.4.9 Contact Resistance: (See Para. 2.3.3)

Five samples were tested and met the 5 milliohms or less requirement of this test at one ampere of current and on the Wheatstone Bridge under standard laboratory conditions.

Three additional samples that were submitted for thermal shock retest did not meet the requirement of 5 milliohms at a current level of one ampere and ranged from 11 to 13 milliohms.

3.4.10 Thermal Shock: (See Para. 2.4.1)

Four samples were tested and met the requirements of this test. There was no evidence of physical damage. However, the coaxial cable (RG 223/U) assembled to the

3.4.10 Thermal Shock (Cont.):

test samples did not withstand the high temperature exposure and deteriorated beyond usage. Since these connectors cannot be disassembled, replacements were authorized and submitted by Mr. Protich at Jet Propulsion Laboratory for thermal shock retest. The sample replacements were assembled to pieces of RG 124/U cable. The dielectric strength, insulation resistance and contact resistance tests were taken as reference data prior to the thermal shock retest. The three new samples met the requirements of the thermal shock retest at 175°C and exhibited no physical damage.

One of the 3 samples tested failed to meet the post thermal shock dielectric strength requirement of 1500V RMS and exhibited a breakdown at 1000V RMS.

None of the 3 samples met the post thermal shock contact resistance requirement of 5 milliohms. The values ranged from 9 to 13 milliohms.

3.4.11 Humidity: (See Para. 2.4.2)

The 3 mated samples tested met the requirements of this test and showed no physical damage.

All 3 samples met the post humidity 1000 megohm insulation test and the 1500V RMS dielectric strength test requirements.

3.0 TEST RESULTS (Cont.) -

3.4 Bendix Corporation (Cont.):

3.4.11 Humidity (Cont.):

None of the 3 samples met the post humidity contact resistance requirement of 5 milliohms. The values ranged from 13 to 15 milliohms.

3.4.12 Salt Spray: (See Para. 2.4.3)

Three samples were tested and met the requirements of this test other than some light cracking occuring on the cable to connector bonding sleeve. The connector itself showed no signs of deterioration of the gold plating or other physical damage.

Two of the 3 samples tested failed to meet the requirements of the post salt spray insulation resistance test of 1000 megohms. The values ranged from 7 to 35 megohms.

Three samples tested failed to meet the post salt spray contact resistance requirement of 5 milliohms. The values ranged from 13 to 19 milliohms.

3.4.13 Cable Retention: (See Para. 2.5.1)

The two samples tested met the 17-pound retention requirement of this test and exhibited no damage.

3.4.14 Cable Twist: (See Para. 2.5.2)

The two samples tested failed to meet the 80 ounce-inches twist requirements of this test. Failures occurred from 13 to 65 ounce-inches.

3.0 TEST RESULTS (Cont.) -

3.4 Bendix Corporation (Cont.):

3.4.15 Center Conductor Push Out: (See Para. 2.5.3)

One sample was tested and met the requirements of this test and exhibited no physical damage.

3.4.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning had destroyed the evidence of failure, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.4.17 Conclusions:

The cause of failure to meet the contact resistance requirements was apparently due to insufficient contact area between the two mating conductor pins. The center conductor pin diameters are sufficient for carrying one ampere of current.

The one sample that failed the post thermal shock dielectric strength test may have been the result of a change in the dielectric characteristic affected by the two temperature extremes. The cause, however, was temporary and no other dielectric strength failures occurred following the remaining environmental tests.

The post salt spray insulation resistance test failures were apparently the result of salt-moisture contamination in and about the junction of the two mating connectors.

3.0 TEST RESULTS (Cont.) -

3.4 Bendix Corporation (Cont.):

3.4.17 Conclusions (Cont.):

Investigation of the cable twist failures showed that the failures were not a result of mechanical insufficiencies on the part of the connectors under test, but rather a weakness on the part of the coaxial cable itself.

3.5 Cannon Electric Company:

3.5.1 Inspection: (See Para. 2.2)

Eighteen straight-angle connectors (12 each CX-PL-F-37 and 6 each CX-JC-M-37) and six bulkhead connectors (CX-RBI-M-0) were inspected upon receipt from Jet Propulsion Laboratory and were of the correct type and quantity, and exhibited no physical damage.

3.5.2 Male Pin Diameter: (See Para. 2.2.1)

The six male pins of connector type CX-JC-M-37 exhibited diameters of 0.0170 to 0.0202 inches. The manufacturer's drawings did not specify male pin diameters.

3.5.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameters of six CX-RBI-M-0 connectors ranged from 0.308 to 0.309 inches and met the clearance requirements for a 0.312 inch diameter mounting hole as specified by the manufacturer.

3.5.4 Contact Gage: (See Para. 2.2.3)

This test was not performed because a spring type male pin equivalent for insertion into the female connector pins was not available from Jet Propulsion Laboratory.

3.5 Cannon Electric Company (Cont.):

3.5.5 Female-Well Depth: (See Para. 2.2.4)

All 13 female connectors had well-depths greater than the length of the mating male pins.

3.5.6 Assembly Evaluations: (See Para. 2.2.5)

The CX-RBI-M-0 connector types are factory assembled units.

The assembly of the CX-PL-F-37 and the CX-JC-M-37 connectors was accomplished with little difficulty and in a reasonable amount of time. The assembled units exhibited no center conductor pin misalignment. The conductor pins are well captivated by the connector shells.

3.5.7 Dielectric Strength: (See Para. 2.3.1)

One of the 10 samples tested failed to meet the 1500V RMS requirement of this test under standard laboratory atmospheric pressure and exhibited a breakdown of 1100V RMS.

All 10 samples met the 100V RMS requirement of this test under high vacuum conditions.

3.5.8 Insulation Resistance: (See Para. 2.3.2)

Ten samples were tested and met the 1000 megohm requirement of this test under standard laboratory conditions.

3.5.9 Contact Resistance: (See Para. 2.3.3)

Ten samples were tested and failed to meet the requirement of 5 milliohms or less and exhibited resistance from 28 to

3.0 TEST RESULTS (Cont.) -

3.5 Cannon Electric Company (Cont.):

3.5.9 Contact Resistance (Cont.):

48 milliohms at a current of one ampere and 23 to 28 milliohms when measured directly on the Wheatstone Bridge.

3.5.10 Thermal Shock: (See Para. 2.4.1)

Eight samples were tested and met the requirements of this test. There was no evidence of physical damage.

None of the eight samples met the post thermal shock contact resistance requirement of 5 milliohms. The range of values was from 23 to 42 milliohms.

All eight samples met the post thermal shock dielectric strength requirement of 1500V RMS.

3.5.11 Humidity: (See Para. 2.4.2)

All eight samples tested met the requirements of this test. There was no evidence of physical damage.

All eight samples met the requirements of the post humidity insulation resistance of 1000 megohms and dielectric strength test of 1500V RMS.

None of the eight samples met the requirement of the post humidity contact resistance of 5 milliohms or less. The values ranged from 27 to 56 milliohms.

3.0 TEST RESULTS (Cont.)-

3.5 Cannon Electric Company (Cont.):

3.5.12 Salt Spray: (See Para. 2.4.3)

Eight samples were tested and met the requirements of this test with only slight discolorations appearing on the surface of the silver plated connector shells.

The eight samples did not meet the post salt spray contact resistance requirement of 5 milliohms or less and exhibited resistances from 32 to 47 milliohms.

All eight samples met the post salt spray insulation resistance requirement of 1000 megohms.

3.5.13 Cable Retention: (See Para. 2.5.1)

Three of the five samples tested met the 17-pound retention requirement of this test and exhibited damage at 3 and 16 pounds.

3.5.14 Cable Twist: (See Para. 2.5.2)

Five samples were tested and failed to meet the 5 pound-inches twist requirement of this test. Failures occurred from 14 to 25 ounch-inches.

3.5.15 Center Conductor Push Out: (See Para. 2.5.3)

The two samples tested met the requirements of this test and exhibited no physical damage.

3.5.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test samples had destroyed

3.0 TEST RESULTS (Cont.) -

3.5 Cannon Electric Company (Cont.):

3.5.16 Failure Analysis (Cont.):

the evidence of failure, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.5.17 Conclusions:

The causes for failing to meet the contact resistance requirements can be equally attributed to insufficient contact area and conductor pin diameters of the mating connector conductor pins.

The cause of one sample, Group 5, breaking down during the initial dielectric strength test was not determinable.

The causes for the cable twist and cable retention failures were found to be directly attributable to the coaxial cables not withstanding the test conditions.

3.6 Federated Radio:

3.6.1 Inspection: (See Para. 2.2)

Ten bulkhead connectors (058350), ten straight connectors (037575), five straight-angle connectors (037775), ten bulkhead connectors (037875) and fifteen right-angle connectors (037675) were inspected upon receipt from Jet Propulsion Laboratory and were found to be correct in type and quantity and exhibited no physical damage.

3.0 TEST RESULTS (Cont.) -

3.6 Federated Radio (Cont.):

3.6.2 Male Pin Diameter: (See Para. 2.2.1)

The fifteen male pins of connector type 037675 exhibited diameters of 0.0301 to 0.0314 inches. The ten male pins of connector type 037575 exhibited diameters of 0.0305 to 0.0309 inches. Manufacturer's specification drawings did not specify male pin diameter.

3.6.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameters of connectors 037875 ranged from 0.308 to 0.310 inches and met the clearance requirements for a 0.312 inch diameter mounting hole as specified by the manufacturer. The major thread diameters of connectors 058350 ranged from 0.186 to 0.187 inches. No manufacturer's specification drawing was furnished.

3.6.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on 058350, 037775, and 037875 female connectors ranged from 4.9 to 15.7 ounces.

3.6.5 Female-Well Depth: (See Para. 2.2.4)

The male pins of all the connectors were longer than the well-depths of the female connectors.

3.6.6 Assembly Evaluations: (See Para. 2.2.5)

Connectors 058350 are factory assembled units.

Some difficulty was experienced in the assembly of the 037675 connectors due to insufficient instructions as to the

3.0 TEST RESULTS (Cont.) -

3.6 Federated Radio (Cont.):

3.6.6 Assembly Evaluations (Cont.):

placement of a washer. The center conductor pins protrude beyond the connector shell on all fifteen connectors. The assembly time for these connectors was longer than usual. No center conductor pin misalignment was noted.

Assembly of the 037775, 037875, and 037575 connectors was found to be easier than for the 037675 connector and was performed in less time. The center conductor pins were flush with the connector shell on the 037775 connectors and protruded on the 037575 and 037875 connectors.

3.6.7 Dielectric Strength: (See Para. 2.3.1)

Ten samples of the 20 tested failed to meet the 1500V RMS requirement of this test. Two of the 10 failures were catastrophic and occurred on samples 037675 : 037775 at 50V RMS, and 037575 : 037875 at 40V RMS. All the above dielectric breakdown occurred under standard laboratory atmospheric pressure.

Three of the twenty samples tested did not meet the 100V RMS requirement under high vacuum conditions. All three samples exhibited breakdown at less than 10V RMS.

3.6.8 Insulation Resistance: (See Para. 2.3.2)

Three of the 20 samples tested were catastrophic failures and exhibited short circuits (zero ohms resistances) under standard laboratory conditions.

3.0 TEST RESULTS (Cont.) -

3.6 Federated Radio (Cont.):

3.6.9 Contact Resistance: (See Para. 2.3.3)

Twenty samples were tested and failed to meet the requirement of 5 milliohms or less and exhibited resistance from 22 to 48 milliohms at one ampere of current and from 22 to 30 milliohms on the Wheatstone Bridge.

3.6.10 Thermal Shock: (See Para. 2.4.1)

Fifteen samples were tested and met the requirements of this test. There was no evidence of physical damage to the connectors. Five samples failed to meet the post thermal shock dielectric strength test of 1500V RMS. One sample, was catastrophic at less than 50V RMS. The 4 other breakdown voltages ranged from 550 to 1400V RMS. None of the 15 samples met the post thermal shock contact resistance requirement of 5 milliohms or less and exhibited resistances from 21 to 33 milliohms at a current level of one ampere.

3.6.11 Humidity: (See Para. 2.4.2)

Fifteen samples were tested and met the requirements of this test. There was no evidence of physical damage to the connectors. Three of the 15 samples failed to meet the post humidity insulation resistance test of 1000 megohms and exhibited breakdowns from 1 to 150 megohms. Eight of the 15 samples did not meet the requirements of the post humidity dielectric strength test of 1500V RMS. One sample was catastrophic and exhibited a short circuit (zero volts).

3.0 TEST RESULTS (Cont.) -

3.6 Federated Radio (Cont.):

3.6.11 Humidity (Cont.):

The 7 other breakdown voltages ranged from 650 to 1050V RMS. All 15 samples tested did not meet the requirements of the post humidity contact resistance test of 5 milliohms or less and exhibited resistances from 29 to 116 milliohms. One sample was open circuited and a catastrophic failure.

3.6.12 Salt Spray: (See Para. 2.4.3)

Fifteen samples were tested and met the requirements of this test other than a slight discoloration and corrosion of the silver-plated surfaces. None of the 15 samples met the requirements of the post salt spray contact resistance test of 5 milliohms or less. The range of resistances exhibited was from 29 to 67 milliohms. Ten of the 15 samples failed to meet the post salt spray insulation resistance requirements of 1000 megohms. Seven of the 10 failures exhibited short circuits and were catastrophic. The remaining 3 breakdown voltages ranged from 2 to 600 megohms.

3.6.13 Cable Retention: (See Para. 2.5.1)

Six of the 15 samples tested failed to meet the 17-pound retention requirements of this test and exhibited damage from 4 to 17 pounds.

3.6.14 Cable Twist: (See Para. 2.5.2)

None of the 15 samples tested met the 5 pound-inch twist requirement of this test. Failures occurred from 4.5 to 15.5 ounce-inches.

3.0 TEST RESULTS (Cont.) -

3.6 Federated Radio (Cont.):

3.6.15 Center Conductor Push Out: (See Para. 2.5.3)

The five samples tested met the requirements of this test and exhibited no physical damage.

3.6.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test samples had destroyed the evidence of failure, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.6.17 Conclusions:

The causes of failure to meet the contact resistance requirements can be equally attributed to insufficient contact area, and conductor pin diameters of the mating connectors.

The catastrophic failures that occurred during the initial electrical tests and then changed to non-catastrophic failures after exposure to the environmental tests suggests the possibilities of inadequate mechanical spacing of components and/or inadequate dielectric material. The same possibilities hold true for the samples that were initially good and then failed after exposure to the environments.

Investigation showed that the cable twist and retention failures were directly attributable to the coaxial cables not being able to withstand the test conditions.

3.0 TEST RESULTS (Cont.)-

3.7 General R.F. Fittings, Inc.:

3.7.1 Inspection: (See Para. 2.2)

Twelve TM 2265 bulkhead connectors, six TNC 2016B bulkhead connectors, six TNC 166B straight-angle connectors, six TM 2200 straight-angle connectors and six TM 2221A right-angle connectors were inspected upon receipt from Jet Propulsion Laboratory and found to be correct in type and quantity and exhibited no physical damage with the exception of one TM 2200 connector. This connector was delivered with the wrong center conductor pin in the parts package. This connector along with its mate, TM 2265, (Group 3) was omitted from testing.

3.7.2 Male Pin Diameter: (See Para. 2.2.1)

The six male pins of connectors TNC 166B exhibited diameters of 0.4085 to 0.0500 inches.

The five male pins of connectors TM 2200 exhibited diameters of 0.0305 to 0.0312 inches.

The six male pins of connectors TM 2221A exhibited diameters of approximately 0.029 to 0.030 inches.

Manufacturer's specifications for male pin diameters were not available.

3.0 TEST RESULTS (Cont.)-

3.7 General R.F. Fittings, Inc. (Cont.):

3.7.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameters of 11 type TM 2265 connectors ranged from 0.308 to 0.310 inches. Six TNC 2016B connectors ranged from 0.499 to 0.500 inches. No manufacturer's specifications were available.

3.7.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on TM 2265 female connectors ranged from 6.4 to 15.8 ounces.

The force measured on TNC 2016B female connectors ranged from 8.6 to 17.6 ounces.

3.7.5 Female-Well Depth: (Para. 2.2.4)

All female connectors had well depths greater than the length of the mating male pins.

3.7.6 Assembly Evaluations: (See Para. 2.2.5)

The TM 2265 connectors were factory assembled units.

The assembly of the TNC 2016B, TNC 166B, TM 2200, and TM 2221A connectors was performed with very little difficulty and in a reasonable length of time. After assembly of the connectors, center conductor pin misalignment was noted on the TNC 2016B connectors from about 3° to 10° of angle, and the pin protruded beyond the connector shells from 1/64 to 1/16 of an inch. Also, the center conductor pins could be moved easily by moving the coaxial cables.

3.0 TEST RESULTS (Cont.) -

3.7 General R.F. Fittings, Inc. (Cont.):

3.7.6 Assembly Evaluations (Cont.):

The remaining connectors exhibited center conductor pins flush with the connector shells and no movement of the center conductor pin resulted from moving the coaxial cables.

3.7.7 Dielectric Strength: (See Para. 2.3.1)

Fourteen samples were tested and met the 1500V RMS requirement of this test under standard laboratory atmospheric pressure and 100V RMS under high vacuum conditions.

3.7.8 Insulation Resistance: (See Para. 2.3.2)

Fourteen samples were tested and met the 1000 megohms requirement of this test under standard laboratory conditions.

3.7.9 Contact Resistance: (See Para. 2.3.3)

Four of the 14 samples tested failed to meet the 5 milliohms or less requirement of this test and exhibited resistances from 12 to 22 milliohms at a current level of one ampere.

Nine of the 14 samples tested failed to meet the 5 milliohms or less requirement of this test and exhibited resistances from 12 to 22 milliohms on the Wheatstone Bridge.

3.7.10 Thermal Shock: (See Para. 2.4.1)

Eleven samples were tested and met the requirements of this test. There was no evidence of physical damage to the connector shells. However, the coaxial cables used on the

3.0 **TEST RESULTS (Cont.)-**

3.7 **General R.F. Fittings, Inc. (Cont.):**

3.7.10 **Thermal Shock (Cont.):**

TNC 2016B: TNC 166B mated connectors did not withstand the high temperature extreme and deteriorated beyond use. Therefore, no post electrical measurements were made at this time. On direction from Mr. Protich at Jet Propulsion Laboratory, new cables (RG 159/U) were assembled to the TNC 2016B: TNC 166B mated connectors and retested in thermal shock. The test samples met the retest requirements.

One of the 11 samples tested failed to meet the post thermal shock dielectric strength requirement of 1500V RMS and exhibited a dielectric breakdown at 600V RMS.

None of the eleven samples tested met the post thermal shock contact resistance requirement of 5 milliohms or less and exhibited resistances from 7 to 35 milliohms.

3.7.11 **Humidity:** (See Para. 2.4.2)

Eleven samples were tested and met the requirements of this test. There was no evidence of physical damage to the connectors.

One of the 11 samples tested failed to meet the post humidity insulation resistance test of 1000 megohms and was a catastrophic failure as a short circuit.

3.0 TEST RESULTS (Cont.)-

3.7 General R. F. Fittings, Inc. (Cont.):

3.7.11 Humidity (Cont.):

Two of the 11 samples tested failed to meet the 1500V RMS requirement of the post humidity dielectric strength test and exhibited breakdowns at 650V RMS and 1450V RMS.

The 11 samples tested failed to meet the post humidity contact resistance requirement of 5 milliohms or less and exhibited resistances of 11 to 77 milliohms.

3.7.12 Salt Spray: (See Para. 2.4.3)

Eleven samples were tested and met the requirements of this test. There was no evidence of physical damage to the connector shells.

None of the 11 samples met the post salt spray contact resistance requirement of 5 milliohms or less and exhibited resistances from 12 to 77 milliohms.

Eight of the 11 samples failed to meet the post salt spray insulation requirement of 1000 megohms and exhibited values from 2 to 30 megohms.

3.7.13 Cable Retention: (See Para. 2.5.1)

Five of the 9 samples tested failed to meet the 17-pound retention requirement and exhibited damage from 9.25 to 16.5 pounds.

3.0 TEST RESULTS (Cont.) -

3.7 General R. F. Fittings, Inc. (Cont.):

3.7.14 Cable Twist: (See Para. 2.5.2)

Four samples were tested and failed to meet the 80 ounce-inches twist requirement of this test. Failures occurred from 5 to 60 ounce-inches.

3.7.15 Center Conductor Push Out: (See Para. 2.5.3)

The three samples tested met the requirements of this test and exhibited no physical damage.

3.7.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test samples had destroyed the evidence of failure, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.7.17 Conclusions:

The contact resistance failures, beginning with the initial measurements, were marginal and steadily increased as the samples were exposed to the environments. This suggests that the contact area of the mating pins may have decreased or that steady increase in contact contamination was occurring or both.

The dielectric strength and insulation resistance failures appear to be due to a change in the properties of the dielectric or physical changes of the connector components or a combination of both as well as possible contamination of the

3.0 TEST RESULTS (Cont.)-

3.7 General R.F. Fittings, Inc. (Cont.):

3.7.17 Conclusions (Cont.):

surfaces at the mating end of the mating connectors as is indicated by the increase of failures during the post salt spray measurements.

The cable twist and cable retention failures were directly attributable to the coaxial cables not being able to withstand the test conditions.

3.8 Gremar Manufacturing Company, Inc.:

3.8.1 Inspection: (See Para. 2.2)

Twelve M6643R bulkhead connectors, six M6636R straight-angle connectors and six M6613R right-angle connectors were inspected upon receipt from Jet Propulsion Laboratory and were found to be correct in quantity and type and exhibited no physical damage.

3.8.2 Male Pin Diameter: (See Para. 2.2.1)

Six M6613R male connector pins exhibited diameters from 0.0225 to 0.0280 inches. The manufacturer's specification was 0.0280 ±0.001 inches.

Six M6636R male connector pins exhibited diameters from 0.0279 to 0.0280 inches. The manufacturer's specification was 0.0280 ±0.001 inches.

3.0 TEST RESULTS (Cont.)-

3.8 Gremar Manufacturing Company, Inc. (Cont.):

3.8.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameters of twelve M6643R bulkhead connectors ranged from 0.371 to 0.375 inches and failed to meet the clearance requirements for mounting hole clearance of $0.370 \begin{smallmatrix} +0.000 \\ -0.005 \end{smallmatrix}$ inches.

3.8.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on M6643R female connectors ranged from 4.3 to 14.0 ounces.

3.8.5 Female-Well Depth: (See Para. 2.2.4)

All 12 female pins had well-depths greater than the insertion length of the mating male pins.

3.8.6 Assembly Evaluations: (See Para. 2.2.5)

The assembly of the M6643R, M6636R and M6613R connectors was performed with some difficulty due to the absence of assembly instructions. With proper instructions, it appears that these connectors would lend themselves readily to mass assembly.

The center conductor pins of the three types exhibited no misalignment after assembly and were slightly captivated by the connector shells.

The center conductor pin of the M6643R connectors could easily be moved by moving or bending the coaxial cable. Mechanical strength is therefore questionable.

3.0 TEST RESULTS (Cont.) -

3.8 Gremar Manufacturing Company, Inc. (Cont.):

3.8.7 Dielectric Strength: (See Para. 2.3.1)

Two of the 10 samples tested failed to meet the 1500V RMS requirement of this test under standard laboratory atmospheric pressure and exhibited breakdown at 550 and 750V RMS.

The 10 samples tested met the high vacuum requirements of this test at 100V RMS.

3.8.8 Insulation Resistance: (See Para. 2.3.2)

The 10 samples tested met the 1000 megohm requirement of this test under standard laboratory conditions.

3.8.9 Contact Resistance: (See Para. 2.3.3)

Two of the 10 samples tested failed to meet the requirement of this test of 5 milliohms or less and exhibited resistances of 14 and 19 milliohms at a current level of one ampere under standard laboratory conditions.

Four of the 10 samples tested failed to meet the requirement of this test of 5 milliohms or less and exhibited resistance from 12 to 22 milliohms on the Wheatstone Bridge.

3.8.10 Thermal Shock: (See Para. 2.4.1)

Eight samples were tested and met the requirements of this test. There was no evidence of physical damage to the connectors. However, the coaxial cables (RG 223/U) used on the M6643R and M6613R connectors did not withstand

3.0 TEST RESULTS (Cont.) -

3.8 Gremar Manufacturing Company, Inc. (Cont.):

3.8.10 Thermal Shock (Cont.):

the high temperature extreme and deteriorated beyond use. Therefore, no post electrical measurements were made at this time.

On direction from Mr. Protich at Jet Propulsion Laboratory, new coaxial cables (RG 159/U) were assembled to the M6613R and M6643R connectors and retested. The 8 samples tested met the requirements of the thermal shock retest.

The 8 samples tested met the 1500V RMS requirements of the post thermal shock dielectric strength test.

The 8 samples tested failed to meet the 5 milliohm post thermal shock contact resistance requirement and exhibited resistances from 9 to 56 milliohms.

3.8.11 Humidity: (See Para. 2.4.2)

All 8 samples tested met the requirements of this test. There was no evidence of physical damage to the connectors.

The 8 samples tested met the 1000 megohm requirement of the post humidity insulation resistance test.

One of the 8 samples tested failed to meet the 1500V RMS requirement of the post humidity dielectric strength test and exhibited a breakdown at 1000V RMS.

3.0 TEST RESULTS (Cont.) -

3.8 Gremar Manufacturing Company, Inc. (Cont.):

3.8.11 Humidity (Cont.):

The 8 samples tested failed to meet the 5 milliohm or less requirement of the post humidity contact resistance test and exhibited resistances from 12 to 64 milliohms.

3.8.12 Salt Spray: (See Para. 2.4.3)

Eight samples were tested and exhibited rust deposits on the sample surfaces at the cable-to-connector interface. Investigation showed that the rusting began on the exposed part of the coaxial cable shield and in turn contaminated the silver plated connector shell. RG 159/U cables were used with these connectors.

All 8 samples tested failed to meet the 5 milliohm or less requirement of the post salt spray contact resistance test. Two samples were catastrophic failures and exhibited open contacts. The resistances of the remaining 6 samples ranged from 12 to 66 milliohms.

Four of the 8 samples tested failed to meet the 1000-megohm requirement of the post salt spray insulation resistance test and exhibited resistances from 3 to 100 megohms.

3.8.13 Cable Retention: (See Para. 2.5.1)

Three of the 6 samples tested failed to meet the 17-pound retention requirement of this test and exhibited damage from 9.5 to 14 pounds.

3.8 Gremar Manufacturing Company, Inc. (Cont.):

3.8.14 Cable Twist: (See Para. 2.5.2)

None of the 6 samples tested met the 80 ounce-inches twist requirement of this test. Failures occurred from 15 to 49 ounce-inches.

3.8.15 Center Conductor Push Out: (See Para. 2.5.3)

The 2 samples tested met the requirements of this test and exhibited no physical damage.

3.8.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test samples had destroyed the evidence of failure, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.8.17 Conclusions:

The initial dielectric strength failures that occurred on two samples changed to acceptable after the first environment of thermal shock. This indicates that a probable change in the dielectric characteristics occurred in these two samples. Another sample that was initially acceptable failed after the humidity test either for the same reason or from moisture infiltration into the connector components or both.

The approximate 50% failure rate exhibited during the initial contact resistance test changed to 100% after exposure to the first environment. There was no change during the

3.0 TEST RESULTS (Cont.) -

3.8 Gremar Manufacturing Company, Inc. (Cont.):

3.8.17 Conclusions(Cont.):

balance of the tests which is probably a result of a reduction of conductor pin contact area, contamination of the conductor pin contact surfaces, or both.

The insulation resistance failures occurred only after salt spray and therefore suggests a definite contamination of the connector components and connecting surfaces.

Cable twist and retention failures were found to be the direct result of the inadequacy of the coaxial cable to withstand the test conditions, and not that of the connectors under test.

3.9 Micon Electronics, Inc:

3.9.1 Inspection: (See Para. 2.2.)

Twelve each 1001, 1101 and 1102 straight-angle connectors, six each 1201, 1301, 1002, 1302 straight-angle connectors, and six each 1019, 1109 and 1110 right-angle connectors were inspected upon receipt from Jet Propulsion Laboratory and found to be correct in type and quantity and exhibited no physical damage.

3.9.2 Male Pin Diameter: (See Para. 2.2.1)

Twelve male pins of each 1001, 1101 connectors, and six male pins of each 1110, 1201 and 1301 connectors exhibited diameters of 0.0201 to 0.0208 inches. Male pin diameter specifications were 0.0200 to 0.0210 inches per manufacturer's drawings.

3.0 TEST RESULTS (Cont.)-

3.9 Micon Electronics, Inc. (Cont.):

3.9.3 Mounting-Hole Clearance: (See Para. 2.2.2)

No chassis or bulkhead type connectors were submitted for this test.

3.9.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on 1002, 1102, 1202, 1302, 1019 and 1109 female connectors ranged from 1.6 to 6.3 ounces.

3.9.5 Female-Well Depth: (See Para. 2.2.4)

All female pins had greater well depth than the insertion length of the mating male pins.

3.9.6 Assembly Evaluations: (See Para. 2.2.5)

The assembly of this type of connector requires a little more time to perform than usual, even though it is not difficult to assemble. This is mainly due to the care required to properly clamp the cable shield with the ferrule component using the seating tool. The reward here is a very mechanically sound cable-to-connector assembly for subminiature connectors.

No center conductor pin misalignment was noted after assembly and all pins were well captivated by the connector shell on all connector types.

3.9.7 Dielectric Strength: (See Para. 2.3.1)

Eight of the 35 samples tested failed to meet the 1500V RMS requirement and exhibited breakdown from 50 to 1050V RMS under standard laboratory atmospheric pressure.

3.0 TEST RESULTS (Cont.) -

3.9 Micon Electronics, Inc. (Cont.):

3.9.7 Dielectric Strength (Cont.):

All of the 35 mated samples tested met the 100V RMS requirement under high vacuum conditions.

3.9.8 Insulation Resistance: (See Para. 2.3.2)

Two of the 35 samples tested failed to meet the 1000 megohm requirement under standard laboratory conditions and exhibited resistances of 1 and 200 ohms. These two failures are catastrophic.

3.9.9 Contact Resistance: (See Para. 2.3.3)

Thirty-three of the 35 samples tested failed to meet the requirement of 5 milliohms or less and exhibited resistances from 6 to 25 milliohms at a current level of one ampere under standard laboratory conditions.

Seventeen of the 35 samples failed to meet the requirement of 5 milliohms or less and exhibited resistances from 6 to 35 milliohms on the Wheatstone Bridge under standard laboratory conditions.

3.9.10 Thermal Shock: (See Para. 2.4.1)

Twenty-eight samples were tested and met the requirements of this test. There was no evidence of physical damage to the connectors.

Seven out of the 28 samples failed to meet the 1500V RMS post thermal shock dielectric strength test and exhibited breakdown from 500 to 1500 V RMS.

3.0 TEST RESULTS (Cont.) -

3.9 Micon Electronics, Inc. (Cont.):

3.9.10 Thermal Shock (Cont.):

None of the 28 samples met the 5 milliohm post thermal shock contact resistance requirement and exhibited resistances from 9 to 94 milliohms.

3.9.11 Humidity: (See Para. 2.4.2)

Twenty-eight samples were tested and met the requirements of this test. There was no evidence of physical damage to the connectors.

Six of the 28 samples failed to meet the 1000 megohm post humidity insulation resistance test and exhibited resistances from less than 1.0 to 90 megohms.

Eleven of the 28 samples failed to meet the 1500V RMS post humidity dielectric strength test and exhibited breakdown from 650 to 1300V RMS.

None of the 28 samples met the requirements of the 5 milliohm post humidity contact resistance test and exhibited resistances from 29 to 95 milliohms. There was an increase in contact resistance from the previous values.

Three samples were catastrophic and demonstrated opens.

3.9.12 Salt Spray: (See Para. 2.4.3)

Rust on the coax cable shield at the connector-to-cable interface was very evident. Light amounts of corrosion was observed on the gold-flashed surfaces of all the connectors.

3.0 TEST RESULTS (Cont.) -

3.9 Micon Electronics, Inc. (Cont.):

3.9.12 Salt Spray (Cont.):

None of the 28 samples met the 5 milliohm post salt spray contact resistance test. Five of the samples were catastrophic failures and demonstrated opens. The remaining twenty-three samples exhibited resistances from 29 to 138 milliohms.

Twenty-three of the 28 samples failed to meet the 1000 megohm post salt spray insulation resistance test and exhibited resistances from 1 to 500 megohms. Two of the 23 were catastrophic and demonstrated shorts.

3.9.13 Cable Retention: (See Para. 2.5.1)

Five of the 21 samples tested failed to meet the 17-pound retention requirement and exhibited damage from 8 to 16 pounds.

3.9.14 Cable Twist: (See Para. 2.5.2)

None of the 21 samples tested met the 80 ounce-inches twist requirement of this test and exhibited failures from 5 to 20 ounce-inches.

3.9.15 Center Conductor Push Out: (See Para. 2.5.3)

The 7 samples tested met the requirements of this test. No physical damage was observed.

3.9.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test samples had destroyed the evidence of

3.9.16 Failure Analysis (Cont.):

failures, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.9.17 Conclusions:

The number of dielectric strength failures that occurred during the initial measurements remained unchanged throughout the remainder of the test program. Therefore, the causes of these failures is assumed to be design inadequacies, if not the lack of assembly tolerances being maintained.

The small number of insulation resistance failures that occurred prior to the salt spray exposure suggests the lack of adequate sealing against salt-moist air.

The 100% failure rate throughout the contact resistance tests is probably the result of inadequate conductor pin contact area which continuously seemed to decrease after exposure to high temperatures. An increase in surface contamination of the contact area would be another likely cause.

Several catastrophic failures (separation of the coax center conductor from the connector center conductor pin) were experienced during the contact resistance tests immediately after thermal shock and suggests that the solder connection between the coax center conductor and the conductor pin was

3.9 Micon Electronics, Inc. (Cont.):

3.9.17 Conclusions (Cont.):

melted during the 175° C temperature extreme and allowed the coax cable to separate from the connector pin. This also accounts for the five failures that occurred during the cable retention test.

The cable twist test resulted in a 100% failure rate. Investigation showed that in all cases the failures were not the result of connector inadequacies but directly a result of the incapability of the small coax cable to withstand the test conditions of 5 pound-inches.

3.10 Microdot, Inc.:

3.10.1 Inspection: (See Para. 2.2)

Eight 32-23 straight-angle connectors, ten 32-15 right-angle connectors, twelve 31-50 bulkhead connectors, six 31-02 bulkhead connectors, two 33-53 bulkhead connectors, four 31-34 straight-angle connectors, eight 52-371 right-angle connectors, ten 52-463 twin-lead straight-angle connectors, five 51-509 twin-lead bulkhead connectors and five 53-570 twin-lead right-angle connectors were inspected upon receipt from Jet Propulsion Laboratory and were found to be correct in type and quantity and exhibited no physical damage, except the four 31-34 connectors had light to moderate tarnishing over the silver plated surfaces of the connector shell.

3.0 TEST RESULTS (Cont.) -

3.10 Microdot, Inc. (Cont.):

3.10.2 Male Pin Diameter: (See Para. 2.2.1)

All the male pins of connectors 32-15, 52-371, 32-23 and 52-463 exhibited diameters from 0.0310 to 0.0320 inches. Manufacturer's specifications were not available for comparison.

3.10.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameters of twelve 31-50 and six 31-02 bulkhead connectors ranged from 0.185 to 0.186 inches and met the mounting hole clearance specified by the manufacturer. The major thread diameters for two 33-53 and five 51-509 connectors ranged from 0.308 to 0.310 inches and met the clearance requirements for a 0.310 inch diameter mounting hole as specified by the manufacturer.

3.10.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on the 51-509 and 53-570 female connectors ranged from 4.1 to 12 ounces.

Insertion force on the 31-20, 31-50, 33-53 and 31-34 female connectors ranged from 11.8 to 29.6 ounces.

3.10.5 Female-Well Depth: (See Para. 2.2.4)

All female pins had well depths greater than the insertion length of the mating male pins.

3.0 TEST RESULTS (Cont.) -

3.10 Microdot, Inc. (Cont.):

3.10.6 Assembly Evaluations: (See Para. 2.2.5)

The 31-50, 33-53 and 31-02 connectors are factory assembled units and do not require coax cables.

The 32-23 and 32-15 connectors were assembled without much difficulty.

The 32-15 and 52-371 connectors take a considerable amount of time to assemble because a solder connection is required in the connector. This is done by heating the connector shell to the soldering temperature, making the connection and waiting for it to cool. Also, the 32-15 connectors exhibited a characteristic of the male pins pulling away from the coax center conductor wire when the connector is disconnected from its mate (connectors 31-50 or 31-34). The male pins of the 32-23, 32-15 and 52-371 connectors protrude up to 1/16 of an inch beyond the connector shell. No center conductor pin misalignment was noted on either connector after assembly. The jerk-relief-ring was also found to be too large on the 52-371 connectors. The 31-34 connectors assembled easily and readily and exhibited no misalignment of the center conductor pin. The center conductor was also well captivated by the connector shell. The 52-463 twin-lead connectors, characteristically, are more difficult and, hence, take longer to assemble than the usual subminiature connectors. The connector center pins were well captivated

3.0 TEST RESULTS (Cont.) -

3.10 Microdot, Inc. (Cont.):

3.10.6 Assembly Evaluations (Cont.):

by the connector shells. The jerk-relief-ring was found to be too large in diameter, resulting in a very inadequate crimp to the coax cable shield. It was noted that in every case the 10-31 assembly tool twisted the twin-lead conductor pins out of proper alignment during the assembly of this conductor.

3.10.7 Dielectric Strength: (See Para. 2.3.1)

Twelve of 28 samples tested failed to meet the 1500V RMS requirement under standard laboratory atmospheric pressure. The range of breakdown voltages were from 500 to 1400V RMS.

One of 28 samples failed to meet the dielectric strength test under high vacuum conditions and exhibited a breakdown at approximately 10V RMS.

3.10.8 Insulation Resistance: (See Para. 2.3.2)

Two of the 28 samples failed to meet the 1000 megohm insulation resistance requirement under standard laboratory conditions and exhibited resistances from 0.4 to 220 ohms.

3.10.9 Contact Resistance: (See Para. 2.3.3)

Thirteen of the 28 samples tested failed to meet the 5 milli-ohm or less requirement at a current level of one ampere, or on the Wheatstone Bridge under standard laboratory conditions. The range of values exhibited were from 6 to 25 milliohms.

3.0 TEST RESULTS (Cont.) -

3.10 Microdot, Inc. (Cont.):

3.10.10 Thermal Shock: (See Para. 2.4.1)

Twenty-two samples were tested and met the requirements of this test. There was no evidence of damage to the connectors.

Six of the twenty-two samples failed to meet the 1500V RMS post thermal shock dielectric strength test and exhibited breakdown from 500 to 1300V RMS.

All twenty-two samples tested failed to meet the 5 milliohm post thermal shock contact resistance requirement and exhibited resistances from 11 to 62 milliohms.

3.10.11 Humidity: (See Para.2.4.2)

The 20 samples tested met the requirements of this test. There was no evidence of physical damage.

Six of the 22 samples failed to meet the 1000 megohms post humidity insulation resistance requirement and exhibited resistances of 1 to 50 megohms. Three of the 22 were catastrophic and exhibited direct shorts.

Eight of the 22 samples failed to meet the 1500V RMS post humidity dielectric strength requirement and exhibited breakdown from 400 to 1400V RMS.

All twenty-two samples failed to meet the 5 milliohms post humidity contact resistance requirement and exhibited

3.10.11 Humidity (Cont.):

resistances from 46 to 101 milliohms which is a considerable increase over the previous readings.

3.10.12 Salt Spray: (See Para. 2.4.3)

The 22 samples tested met the requirements of this test although corrosion was noted on the film of solder covering the access caps on the 32-15 and 52-371 right-angle connectors.

All of the 22 samples failed to meet the 5 milliohms post salt spray contact resistance requirement and exhibited values from 47 to 140 milliohms.

Fifteen of the 22 samples failed to meet the 1000 megohm post salt spray insulation resistance requirement and exhibited values from 3 to 150 megohms. Three of the fifteen samples exhibited shorts and were catastrophic.

3.10.13 Cable Retention: (See Para. 2.5.1)

Two of the 18 samples tested failed to meet the 17-pound retention requirement and exhibited damage at 11 and 14.75 pounds.

3.10.14 Cable Twist: (See Para. 2.5.2)

None of the 18 samples tested met the 5 pound-inches twist requirement of this test. Failures occurred from 4.5 to 45 ounce-inches.

3.0 TEST RESULTS (Cont.) -

3.10 Microdot, Inc. (Cont.):

3.10.15 Center Conductor Push Out: (See Para. 2.5.3)

The 6 samples tested met the requirement of this test and exhibited no physical damage.

3.10.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test samples had destroyed the evidence of failure, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.10.17 Conclusions:

The failures demonstrated during the initial 1500V RMS dielectric strength test decreased after the first environment and remained unchanged throughout the remainder of the environments. The first environment was thermal shock and contained the highest and lowest temperature exposure. With this in mind, the probable reasons for the dielectric strength failures is equally due to connector components expanding and contracting and/or inadequate isolation of the components by the dielectric material.

The steady increase in the insulation resistance failures occurred throughout the environmental sequence and is related to the same causes of the dielectric strength failures.

3.0 TEST RESULTS (Cont.)-

3.11 Sealectro Corporation:

3.11.1 Inspection: (See Para. 2.2)

Twelve 3102 bulkhead, six 3100 straight-angle and six 3105 right-angle connectors were inspected upon receipt from Jet Propulsion Laboratory and found to be correct in type and quantity and exhibited no physical damage.

3.11.2 Male Pin Diameter: (See Para. 2.2.1)

All male pin diameters of the twelve 3102 male connectors were approximately 0.021 inches and met the manufacturer's specification of 0.020 to 0.021 inches.

3.11.3 Mounting-Hole Clearance: (See Para. 2.2.2)

The major thread diameters of twelve 3102 bulkhead connectors ranged from 0.187 to 0.191 inches and met the clearance requirements for a 0.203 inch diameter mounting hole as specified by the manufacturer.

3.11.4 Contact Gage: (See Para. 2.2.3)

The insertion force measured on the 3100 female connectors varied from 2.7 to 2.9 ounces, and the 3105 female connectors varied from 3.8 to 4.4 ounces.

3.11.5 Female-Well Depth: (See Para. 2.2.4)

All female pins had well-depths greater than the insertion length of the mating male pins.

3.11.6 Assembly Evaluations: (See Para. 2.2.5)

The 3102 type connectors are a factory assembled unit.

Assembly of the 3105 and 3100 type connectors requires a

3.0 TEST RESULTS (Cont.)-

3.11 Sealectro Corporation (Cont.):

3.11.6 Assembly Evaluations (Cont.):

little more time to perform than usual although they are not difficult to assemble. The reason for this is due mainly to the care required to properly seat the ferrule component against the cable shield with the seating tool. The reward here is a very mechanically sound cable-to-connector assembly for subminiature connectors.

No center conductor pin misalignment was noted on any of the assembled connectors and all connectors exhibited well captivated center conductor pins by the connector shells.

3.11.7 Dielectric Strength: (See Para. 2.3.1)

One of the 10 samples tested failed to meet the 1500V RMS requirement under standard laboratory atmospheric pressure. The sample exhibited a breakdown at 900V RMS.

The 10 samples met the 100V RMS requirement under high vacuum conditions and exhibited no physical damage.

3.11.8 Insulation Resistance: (See Para. 2.3.2)

The 10 samples met the 100 megohm requirement under standard laboratory conditions and exhibited no physical damage.

3.0 TEST RESULTS (Cont.)-

3.11 Sealectro Corporation (Cont.):

3.11.9 Contact Resistance: (See Para. 2.3.3)

Seven of the 10 samples tested failed to meet the 5 milliohm or less requirement at a current level of one ampere under standard laboratory conditions and exhibited resistances from 6 to 19 milliohms. One of the seven samples exhibited an open circuit and was catastrophic.

Four of the 10 samples failed to meet the 5 milliohm or less requirement on the Wheatstone Bridge under standard laboratory conditions and exhibited resistances from 25 to 28 milliohms. One sample still exhibited an open circuit.

3.11.10 Thermal Shock: (See Para. 2.4.1)

The 8 samples tested met the requirements of this test. There was no evidence of physical damage to the connectors.

One of the 8 samples failed to meet the 1500V RMS post thermal shock dielectric strength requirement and exhibited a breakdown at 1250V RMS.

Six of the 8 samples failed to meet the 5 milliohm post thermal shock contact resistance test and exhibited resistances from 6 to 44 milliohms. One sample had changed from an open to 44 milliohms.

3.0 TEST RESULTS (Cont.)-

3.11 Sealectro Corporation (Cont.):

3.11.11 Humidity: (See Para. 2.4.2)

All 8 samples tested met the requirements of this test. There was no evidence of physical damage to the connectors.

All 8 samples met the 1000 megohms post humidity insulation resistance test.

All 8 samples failed to meet the 5 milliohm or less post humidity contact resistance requirement and exhibited resistances from 26 to 41 milliohms. Four of the 8 samples showed an increase in contact resistance of 400 per cent.

3.11.12 Salt Spray: (See Para. 2.4.3)

The 8 samples tested all experienced very slight amounts of corrosion or discolorations over the gold flash surfaces from this test.

All 8 samples failed to meet the 5 milliohm or less post salt spray contact resistance test and exhibited resistances from 28 to 44 milliohms.

Six of the 8 samples did not meet the 1000 megohm post salt spray insulation resistance test and exhibited resistances from 0 to 780 megohms. Two of the 6 were shorted and are catastrophic failures.

3.0 TEST RESULTS (Cont.)-

3.11 Sealectro Corporation (Cont.):

3.11.13 Cable Retention: (See Para. 2.5.1)

One of the 6 samples tested failed to meet the 17-pound retention requirement and exhibited damage at 4 pounds.

3.11.14 Cable Twist: (See Para. 2.5.2)

None of the 6 samples tested met the 5 pound-inches twist requirement of this test. Failures occurred from 12 to 17 ounce-inches.

3.11.15 Center Conductor Push Out: (See Para. 2.5.3)

The two samples tested met the requirements of this test and exhibited no physical damage.

3.11.16 Failure Analysis:

Visual examination of the mated connector samples disclosed that the damage incurred as the result of sectioning the encapsulated test samples had destroyed the evidence of failure, rendering it impossible to analyze the type of failure resulting from environmental exposure.

3.11.17 Conclusions:

It was found that the one sample that exhibited a dielectric breakdown throughout the test program as well as an open circuit during the initial contact resistance test was the result of the center conductor pin of the 3105 right-angle connector somehow being pulled back into the connector body just enough not to make contact with the mating center conductor pin and being exposed to the connector shell without the benfit of the teflon dielectric. After

3.0 TEST RESULTS (Cont.)-

3.11 Sealectro Corporation (Cont.):

3.11.17 Conclusions (Cont.):

thermal shock exposure, thermal expansion allowed the 3105 conductor pin to contact its mating conductor pin just enough to produce a reading, but not enough to eliminate the dielectric breakdown failure. This is a potential problem in all the 3105 right-angle connectors since there is no means provided to inhibit center conductor pin backup.

The inherent high contact resistance readings are most likely a result of insufficient contact area between the male and female mating pins.

Insulation resistance failures increased just after salt spray exposure and clearly indicates inadequate sealing against contaminated air.

The high percentage of cable twist failures was found not to be the result of inadequate connector design but rather a direct result of the inability of the coaxial cables to withstand the test conditions.

4.0 SUMMARY-

4.1 Manufacturer Comparison Table:

The following Table III is arranged alphabetically by manufacturer and compares the results of testing in test sequence order.

4.0 SUMMARY (Cont.) -

4.1 Manufacturer Comparison Table (Cont.):

TABLE III

Comparison of Test Results Between Manufacturers	Amphenol Corp.	Automatic Metals	Aviel Electronics	Bendix Corp.	Cannon Electric	Federated Radio	General R. F. Fittings, Inc.	Gremar Mfg.	Micon Electronics	Microdot Corp.	Sealectro Corp.
Dielectric Strength (Initial)	22/2	10/1	5/0	8/0	10/1	20/10	14/0	10/2	35/8	28/12	10/1
Dielectric Strength (High Vacuum)	22/0	10/0	5/0	8/0	10/0	20/3	14/0	10/0	35/0	28/1	10/0
Insulation Resistance (Initial)	22/0	10/1	5/0	8/0	10/0	20/3	14/0	10/0	35/2	28/2	10/0
Indirect Contact Resistance (Initial)	22/15	10/10	5/5	8/3	10/10	20/20	14/4	10/2	35/33	28/13	10/7
Direct Contact Resistance (Initial)	16/12	10/10	5/0	8/3	10/10	20/20	14/9	10/4	35/17	28/25	10/4
Dielectric Strength (Post Thermal Shock)	6/0	8/1	4/0	3/1	8/0	15/5	11/1	8/0	28/7	22/6	8/1
Indirect Contact Resistance (Post Thermal Shock)	6/6	8/8	4/4	3/3	8/8	15/15	11/11	8/8	28/28	22/22	8/6
Dielectric Strength (Post Humidity)	6/0	8/1	4/0	3/0	8/0	15/8	11/2	8/1	28/11	22/8	8/1
Insulation Resistance (Post Humidity)	6/0	8/1	4/0	3/0	8/0	15/3	11/1	8/0	28/6	22/6	8/0
Indirect Contact Resistance (Post Humidity)	6/6	8/8	4/4	3/3	8/8	15/15	11/11	8/8	28/28	22/22	8/8
Insulation Resistance (Post Salt Spray)	6/1	8/4	4/1	3/2	8/8	15/15	11/11	8/8	28/28	22/22	8/8

4.0 SUMMARY (Cont.)-

4.1 Manufacturer Comparison Table (Cont.):

TABLE III (Cont.)

Comparison of Test Results Between Manufacturers	Amphenol Corp.	Automatic Metals	Aviel Electronics	Bendix Corp.	Cannon Electric	Federated Radio	General RF Fittings, Inc.	Gremar Mfg.	Micon Electronics	Microdot Corp.	Sealectro Corp.
Indirect Contact Resistance (Post Salt Spray)	6/6	8/8	4/4	3/3	8/8	15/15	11/11	8/8	28/28	22/22	8/8
Cable Retention	8/6	6/0	3/0	2/0	6/3	15/6	11/5	6/4	21/5	18/2	6/1
Cable Twist	6/6	6/0	3/1	2/2	5/5	15/15	4/4	6/6	21/21	18/18	6/6
Center Conductor Push Out	4/0	2/0	1/0	1/0	2/0	15/0	3/0	2/0	7/0	6/0	2/0

Number of mated Samples tested → [/] ← Number of mated Samples failed

4.2 Characteristics Similarities:

As is evidenced by Table III, all the connector types submitted by the different manufacturers demonstrates similar characteristics in design and, especially, performance. Similarity in design problems is evidenced in comparing the causes for the different failures noted in the conclusions for each manufacturer.